NISTTech

ChemNose -Application of Microsubstrates for Materials Processing

Low-power, accurate electronic olfactory 'nose' suitable for a wide range of applications

Description

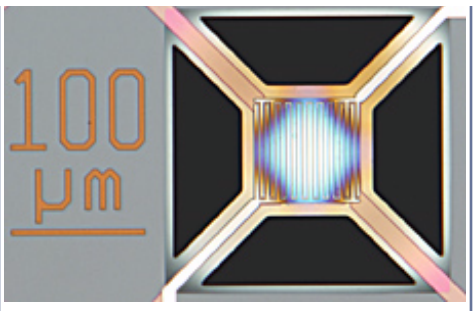
Combining a sensitive detector technology capable of distinguishing hundreds of different chemical compounds with a pattern-recognition module that mimics the way animals recognize odors results in a new approach for "electronic noses." ChemNose is adept at recognizing molecular features even for chemicals it has not been trained to detect and is robust enough to deal with changes in sensor response that come with wear and tear. The tunability of the new approach means that a variety of chemical warfare agents and toxic industrial chemicals in air-based backgrounds can be detected despite challenging interferences. New signal analysis schemes hold the potential for properly classifying "unknowns."

Among the attractive features inherent in ChemNose are small size (individual device structures are ~100 microns square, and unpackaged arrays fit on a 1 mm × 1 mm chip), low power consumption (battery operation), and tunability. Since it is fabricated through CMOS-compatible silicon technology, electronics can be added to enhance operational signal handling architectures and lower unit costs. Ease of integration and CMOS- compatibility aids coupling telemetry with the microsensors - thereby enabling network deployment. In addition, its robustness against the effects of sensor drift will facilitate its commercialization across a broad range of applications.

ChemNose is based on interactions between chemical species and semiconducting sensor materials placed on top of MEMS microheater platforms developed at NIST. Eight types of sensors in the form of oxide films are deposited on the surface of 16 microheaters, with two copies of each material. Precise control of each of the individual heating elements allows each to be treated as a collection of virtual sensors at 350 temperature increments between 150 to 500 deg C, thus increasing the sensor number to ~ 5,600. The combination of sensing films and the ability to vary the temperature gives the device the analytical equivalent of a snoot full of sensory neurons.

See NIST Dockets 92-045, 92-046, and 96-047

Images



Credit: NIST Possible applications include sniffing out nerve agents, environmental contaminants, and trace indicators of disease, in addition to monitoring industrial processes and aiding in space exploration.

Applications

- **First Responders**
  Ideal for emergency response teams at possible chemical spill sites
- **Chemical processing and transportation**
  Useful as a primary alert for potential exposure to numerous toxic industrial chemicals and chemical warfare agents
- **Homeland security**
  Identifies the presence of many dangerous chemicals and can classify lesser known substances

Advantages

- **Portable**
  Compact design of approximately 100 microns square
- **Network capable**
  Add CMOS-compatible and additional electronics directly to the chip for easy integration
- **Low power**
  Battery operated
- **Autonomous**
  "All-in-one" design does not require additional components
- **Adaptable**
  Capable of classifying "unknown" chemical compounds in addition to being able to pin point specific chemical warfare agents and toxic industrial chemicals

Abstract

Arrays of microfabricated hotplates have been used as substrate arrays for materials processing on a microscopic scale. Properties of individual elements (pixels) of the array, such as temperature and voltage bias, are controlled by addressing a given pixel with appropriate signals. Materials are deposited onto pixels with individually controlled deposition conditions (pixel temperature, bias). Pixels are also addressed to control properties during post-deposition processing steps such as heating in vacuum or various gases to alter stoichiometry of a single material, or to alloy multiple composition materials. The addressable heating characteristics may also be used for a maskless lithography on pixel elements. The result is an array of separately, but simultaneously, processed films. Properties of film elements may be measured using electrical contact pads. The array of processed films may be used for sensors, electronic devices, greatly accelerated materials development processes, and solid state physics, biology and chemistry studies.

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Citations

1. - ***NIST Docket Number:*** 92-045
     U.S. Patent # 5,464,966
   - ***NIST Docket Number:*** 92-046
     U.S. Patent # 5,345,213
   - ***NIST Docket Number:*** 96-047
     U.S. Patent # 6,095,681

Related Items

- Article: Sniffing Out a Better Chemical Sensor
- Article: Microsensors Sniff Out Gases
- Article: Designing an Ultrasensitive "Optical Nose" for Chemicals

References

- U.S. Patent # 5,356,756
- Docket: 92-047US

Status of Availability

This invention is available for licensing.

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